Smart cities in Europe

The future of urban mobility

Understanding the challenge

From the emergence of Uber taxis and ultra-fast railways to paperless tickets and smartphone travel apps, travelling around cities has changed dramatically in the past ten years. But with the population density of urban areas increasing across Europe – almost three-quarters of Europeans currently live in cities – more innovation is needed to ensure that people and goods can travel in a quick and effective yet safe manner.

This report, the second in a series of white papers produced in collaboration with The Lawyer Research Service, explores what urban mobility might look like in future smart cities. It examines which new technologies and business models are not only capable of fundamentally changing transport in cities but also have a realistic chance of being implemented at scale. We also analyse the challenges associated with introducing innovative solutions to the transport sector; how these obstacles can be overcome; and what the impact will be on incumbent market participants, be they existing transport operators or large automotive manufacturers.

We start with three case studies examining new business models and technology that have the potential to revolutionise travel.

Case studies

Car sharing – remedying the innate inefficiency of automotive travel

Car travel is hugely inefficient. On average, cars are only used for about 5% of the day. When in use, the average occupancy rate is 1.2 people per car[1]. Vehicles, therefore, represent a huge untapped resource. One way of addressing this inefficiency is car-sharing. This takes various forms, but the most common is short-term car rental, often by the hour, from a car rental company.

Who are the most active players? Car clubs and ride-sharing businesses such as Zipcar and Bla-BlaCar have been established for some time, however, recently major car manufacturers have also entered the market. BMW launched its pay-as-you-go service DriveNow in London in late 2014 following successful trials across Germany, Vienna and San Francisco. The service, which is a joint venture with Sixt, matches users' locations with available cars. Vehicles are accessed by pressing a chip found in the driver's member card on a windscreen reader. Mercedes-Benz rolled out its Car2Go offering in Europe and North America. A convenient feature of DriveNow or Car2Go is that vehicles can be left in any public space, not necessarily in a designated drop-off point. Earlier this year, rival car maker Ford launched its app-based pay-as-you-go service, GoDrive, in London.

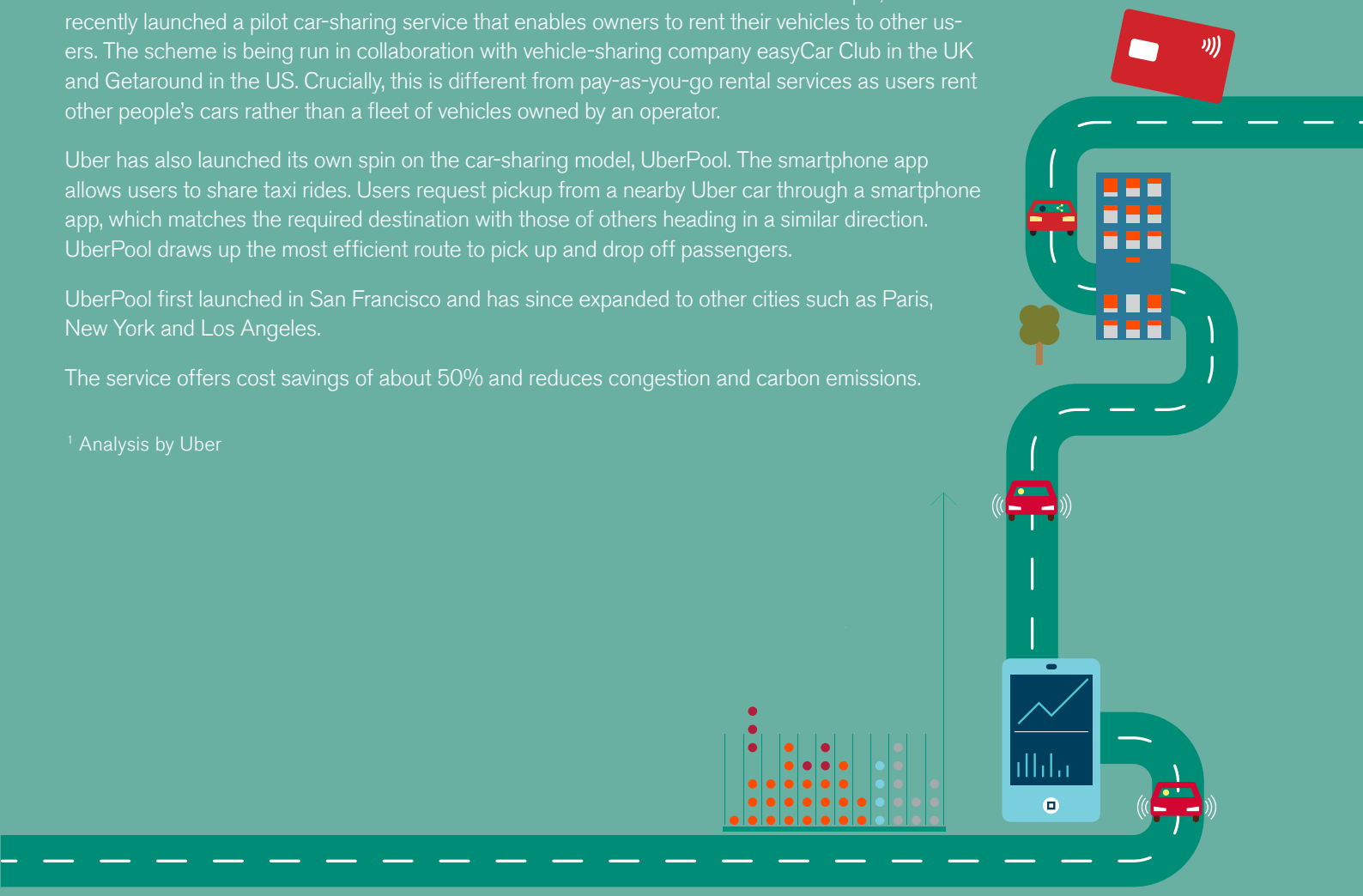
Some vehicle manufacturers have started to offer more innovative solutions. For example, Ford recently launched a pilot car-sharing service that enables owners to rent their vehicles to other users. The scheme is being run in collaboration with vehicle-sharing company easyCar Club in the UK and Getaround in the US. Crucially, this is different from pay-as-you-go rental services as users rent other people's cars rather than a fleet of vehicles owned by an operator.

Uber has also launched its own spin on the car-sharing model, UberPool. The smartphone app allows users to share taxi rides. Users request pickup from a nearby Uber car through a smartphone app, which matches the required destination with those of others heading in a similar direction. UberPool draws up the most efficient route to pick up and drop off passengers.

UberPool first launched in San Francisco and has since expanded to other cities such as Paris, New York and Los Angeles.

The service offers cost savings of about 50% and reduces congestion and carbon emissions.

[1] Analysis by Uber



Case studies

Automated vehicles – Milton Keynes launches pilot but buses may be early adopters

Ask anyone about autonomous vehicles and images of Google's driverless pod-like cars will likely come to mind first. In fact, there are numerous intermediate levels of automation – involving tasks ranging from advanced warning systems to parking assistance – that are either already being introduced or are close to being rolled out by major manufacturers.

As outlined in the table below, The Society of Automotive Engineers has identified six stages of automation, from no automation (level 0) to full automation (level 5).

"The industry is currently on level 2, as defined by The Society of Automotive Engineers," said Evangelos Bekiaris, Research Director at the Hellenic Institute of Transport. "At this level, the car can only do specific tasks like parking or traffic-jam assistance, but everything else is done by the driver. We are currently moving to level 3 and will probably be there in a few years. This level is the critical phase, I believe, where the car can drive automatically but the driver can take control whenever they want."

Vehicle automation doesn't just apply to cars. In fact, according to Timothy Jackson, CEO, Great Britain & Ireland at RATP Dev, buses are best suited to driverless technology.

Summary of levels of driving automation for on-road vehicles

Level	Name	Narrative Description	Execution of Steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving* task	System capability (*driving modes*)
		Human driver monitors the environment				
0	**No automation**	The full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	**Driver automation**	The *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving* task	Human driver and system	Human driver	Human driver	Some driving modes
2	**Partial automation**	The *driving mode*-specific execution by one or more driver assistance system of both steering and acceleration/deeleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	System	Human driver	Human driver	Some driving modes
		Automated driving system ("system") monitors the driving environment				
3	**Conditional automation**	The *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task* with the expectation that the human driver will respond appropriately to a *request to intervene*	System	System	Human driver	Some driving modes
4	**High automation**	The *driving mode*-specific performance by an *automated driving system* of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	System	Some driving modes
5	**Full automation**	The full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	All driving modes

Case studies

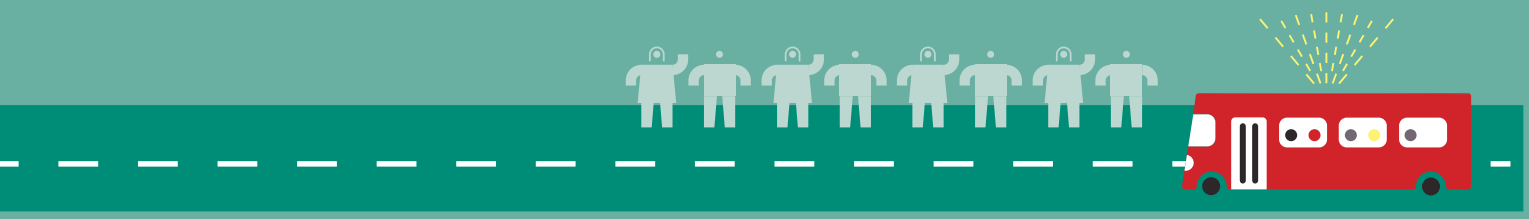
"The real game changer isn't in autonomous cars but buses," he said. "Buses stick to a route on a map in a way that cars obviously don't. They do the same route every day, week after week, so it should technically be easier to automate them. In addition, drivers represent between 40% and 60% of the cost base of bus companies, so there is a real financial incentive for going driverless. This hasn't happened yet, but I'm certain it will."

In the UK, the most advanced deployment of fully autonomous vehicles is in Milton Keynes, where driverless pod vehicles are being trialled at a mile-long stretch of pedestrianised space between the town's train station and the main shopping centre.

The vehicles, called LUTZ Pathfinders, deploy 22 external sensors to monitor their surroundings. Coupled with sophisticated artificial intelligence capabilities, the pods are able to visualise their surrounding environment and navigate through it. The first version of the vehicles will have a six-hour range and a maximum speed of 15 mph.

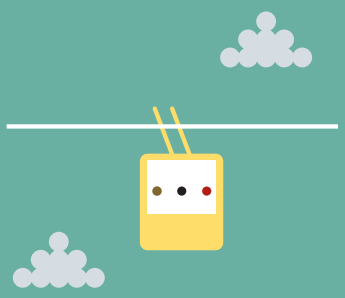
The pilot is being run by the Transport Systems Catapult. Three pods will be trialled this year. Findings from the study will be fed into a larger-scale trial of 40 pods in Milton Keynes and Coventry.

German trials are conducted near Munich and Stuttgart on defined stretches of the Autobahn, where vehicle automation is tested in less complex traffic situations but at higher speeds. Inner-city trials will commence near the Audi headquarters in Ingolstadt in 2018.



Aerial travel – a realistic alternative to cars and buses?

Transport above street level has some obvious advantages. Not having to share lanes with cars and buses means it could be faster than driving on the road. Most proposed aerial transport schemes do not consume fuel, so are more environmentally friendly. Developers of aerial travel systems also claim that journeys are less expensive. However, the high costs of establishing the necessary infrastructure and the lack of proven technology available mean that aerial transport is almost non-existent in cities.



There are signs that this is changing. In April 2015, Herzliya Municipality, Israel, announced early plans to build a pilot aerial cable car based on magnetic levitation technology to transport people between the train station and the marina. The system will be based on technology developed by NASA and private company skyTran. Uniquely, users will be able to order pods to take them directly to their destination, bypassing unnecessary stations.

The cable cars will be able to transport two passengers per car and up to 12,000 people per hour. The second phase of the project will expand the network to industrial and commercial areas of the city.

The project is still in the early stages and will have to overcome a number of obstacles before coming to fruition. However, the fact that the city has initiated the process and received backing from the local mayor provides a strong indication that it will go ahead.

Hearing from the experts

To understand how transport in cities will change in the next five years, we interviewed eight market experts. Three main themes emerged. First, better collection, analysis and visualisation of data could potentially improve transport systems radically. Second, outdated legal and regulatory frameworks are a major barrier to innovation in transport. Third, incumbent transport operators and vehicle manufacturers must invest in improving their service offering to compete with new business models and technology.

1. Data is at the heart of transport innovation.

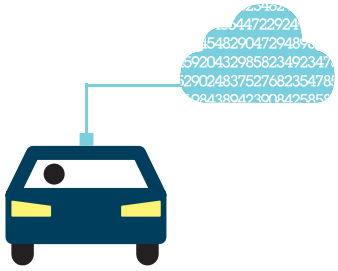
Access to data enables effective planning.

The consistent message from our expert panel was that great strides can be made by simply making better use of existing data. Take travel data. Most city planners simply don't have access to granular information on the number, route or reason for journeys across cities. This data is often too expensive to collect and analyse, or simply isn't provided by private transport operators or vehicle manufacturers. When this data is available, it is often in a format that is not compatible with other data streams. However, as Richard Harris, Director of Communications and Marketing at Xerox, explains, having access to and visualising this data is extremely powerful for transport authorities and companies.

"The main transport advances will come from using data analytics to make better informed decisions," Harris said. "To do this, we don't need any technological advances, just better organisation and administration to break down the silo mentality. Our Mobility Analytics Platform sits over the public transportation operation and analyses and visualises journeys and journey times. This helps authorities understand demand and make plans to satisfy it."

Unleashing data can spur business-model innovation.

Access to data does not just facilitate better planning; it also enables the creation of new business models capable of improving transport. A good example is the London Datastore, a free and open data-sharing portal providing data relating to the capital, managed by the Greater London Authority. In collaboration with Transport for London, huge volumes of real-time data has been released to citizens and businesses. The organisation also engages with developers it hopes can create innovative apps based on this data. According to the Greater London Authority, more than five thousand developers have registered to receive this open data and hundreds of apps have been created, the most famous being Citymapper.



"The main transport advances will come from using data analytics to make better informed decisions. To do this, we don't need any technological advances, just better organisation and administration to break down the silo mentality."

"Huge volumes of data related to travel are already being gathered from mobile phones and sensors that are in and around cities," said Simon Spooner, Partner at Osborne Clarke. "This should be used to improve travel. Citymapper is already doing this: leveraging the open data that the London transport authority TfL puts into the London Datastore. This provides a great opportunity for new businesses to potentially identify new business models. The more standards are open, the more data can be used by more people, and the more innovation there will be in business models."

Data doesn't just have the potential to revolutionise public transport. Indeed, most major car manufacturers collect huge volumes of data on car location, performance and the degradation of key parts. If this data were put into the public domain then private-sector companies could potentially create new business models based on, for example, offering targeted repair services to vehicles in need of servicing.

"Motor insurers offer tailored premiums to consumers who allow them to track their driving patterns. Telematics data can also be used to offer garage services, or for other targeted in-vehicle advertising – like coupons for nearby petrol stations or restaurants," said Thomas Funke, Partner at Osborne Clarke. "In the multi-billion markets for parts and servicing, the information that a vehicle is in need of repair or servicing is priceless. BMW already advertises that it will have all parts waiting for you when you bring your connected car to the shop. This is difficult for non-franchised repairers to match. So data is quickly becoming essential for aftermarket competition."

2. Legal and regulatory issues are major obstacles to innovation.

Our expert panel of interviewees consistently pointed to out-of-date regulation and prohibitive laws as impediments to the implementation of new transport technologies and business models, particularly in relation to connected and autonomous vehicles. However, interviewees also pinpointed new regulations as a potential enabler of innovation. Of course, the legal and regulatory challenges are very specific to the type of transport and business model. The most important are outlined below.

Regulatory change needed for autonomous vehicles to become mainstream

Most European countries are signatories to the Vienna Convention on Road Traffic. This means that every moving vehicle or combination of vehicles must have a driver and that every driver should always be in control of their vehicle. This convention is in the process of being amended so that vehicles can drive themselves, as long as a human driver is capable of instantly resuming control. This creates an adequate legal context for a certain degree of automation, though further reform of the Vienna Convention is likely to be necessary to allow fully driverless vehicles.

"The Vienna Convention on Road Traffic, which the UK has not ratified, specifies roadworthiness conditions for vehicles and says that ultimately a driver must be in control of or capable of resuming control of their vehicle," said Thomas Funke, Partner at Osborne Clarke. "Business statutes will allow a certain degree of automation, but this will likely need to be changed to allow the advent of totally autonomous cars."

And, seemingly, whenever autonomous vehicles are mentioned the question of liability inevitably comes up. Who really is liable should an autonomous vehicle cause an accident – the driver or the vehicle manufacturer or someone else? The emergence of more automated functions in vehicles is triggering regulators and others to review this issue. Clarification is needed because manufacturers will not want to be liable for accidents caused by human error while drivers will not want to be responsible for accidents caused by faulty automation technology. Ultimately, will the liability matrix change materially? Perhaps not.

Vehicle manufacturers have adopted different stances on the subject. Volvo recently stated that it will accept full liability for accidents involving its driverless cars as long as the driver has not used the technology inappropriately. However, other vehicle manufacturers have announced that liability for potential accidents during automated manoeuvres will be placed on the driver.

Despite the many regulatory barriers to wider adoption of automated vehicles, regulation can also enable the industry to develop. Evangelos Bekiaris, Research Director at the Hellenic Institute of Transport, believes insurance is an area where regulation could help expedite the proliferation of autonomous vehicles.

"Autonomous vehicles need to be insured by law," Bekiaris said. "Down the line insurers will be prepared to do this once they recognise that autonomous vehicles are involved in fewer accidents. But we need them to insure these vehicles now. Regulators could force insurance companies to cover autonomous cars at premiums similar to standard vehicles to help get over this hurdle."

Outdated type-approval law stunts connected car market.

Connected cars are also likely future disruptors. Put simply, connected cars are those capable of transmitting and receiving data over the internet or a wireless local area network. They often include equipment that leverages data collected outside the car, which provides benefits to the driver and passengers, such as safety alerts, weather updates and even the latest music and TV shows. Connected cars also transmit

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data collected within the vehicle back to the manufacturer. Such data might include the location of the vehicle, the mileage and the degradation level of key components.

Consumer organisations and trade associations are lobbying for data on degradation to be made available to third parties interested in providing aftermarket repair services. However, the EU Commission has yet to apply its sector-specific competition guidelines to the new world of connected cars. The EU type-approval regime refers to remote diagnostics data having to be shared with independent operators, but is rarely enforced. These norms stipulate that any vehicle manufacturer must make any information required for vehicle servicing or repair available to interested third parties, including repair instructions, fault codes and access to on-board systems, among a number of other metrics.

"These norms should be interpreted as relating to telematics data because information that a vehicle is in need of servicing or repair is data that is highly relevant for competition in the servicing and repair market," said Thomas Funke, Partner at Osborne Clarke. "We would have much greater clarity if the EU legislator, who is in the process of amending these regulations, inserted specific wording clarifying this."

Other legal considerations

Our expert panel of interviewees noted a number of other legal obstacles to the roll-out of intelligent transport systems, the most common being laws relating to public procurement, data protection and privacy, and the regulation of new business models such as Uber's.

"The biggest legal issue relates to data privacy and data protection," said Philipp Haas, Head of Legal Services for Information Technology at Bosch. "Lots of new transport technologies create a lot of data and the question is how you protect this, who it belongs to, how you gain consent and who is allowed to do what with it. Companies in this space have to comply with the data privacy act but the market is very split up at the moment. We have European regulation but this only relates to a small part of data-protection law, meaning every country in Europe has its own law that you have to comply with. The EU Parliament is working on a unified data-protection act across Europe that will more unify the European data-protection laws, but it still won't be completely even because many countries will make use of the opening clauses."

A lack of finance and outdated legacy infrastructure also impede innovation.

Alongside legal and regulatory issues, interviewees frequently mentioned a lack of finance and outdated legacy infrastructure as major barriers to the introduction of innovative transport technology and business models. A lack of finance limits the pace of innovation in many ways – at the stage where new transport technology is being developed and tested and also when it is being rolled out. Our previous report 'Financing the commercialisation of smart city technology', released in July 2015, explores how this funding gap can be closed through close collaboration between the public and private sectors.

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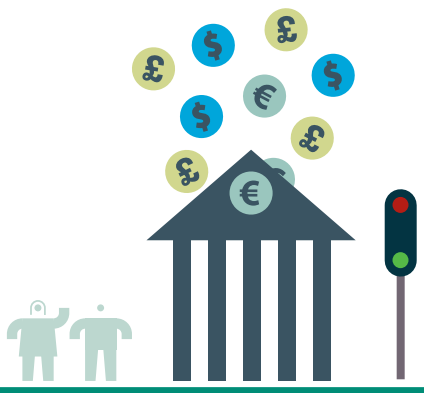

3. The incumbent players – rising to the challenge?

Many of the emerging innovative technologies and business models in city transport have been brought to market by small private companies that are new to the sector. An interesting question is, therefore, how the established players, be they large vehicle manufacturers or transport operators, respond.

Uber is a classic case. The company's ongoing conflict with traditional taxis is well documented, as are the challenges to Cabify in Madrid or Wundercar in Hamburg. But other modes of transport will undoubtedly come under threat if UberPool takes off. The low cost means that buses might also be threatened.

"Buses need to address this as UberPool is not a flash in the pan," said Simon Spooner, Partner at Osborne Clarke. "To compete they need to innovate, such as by perhaps offering more on-demand services, rather than just a set of bus routes. They recognise the challenges from other business models, but haven't yet decided how to respond. Can a rail or bus operator continue to act as they are? For buses, especially, I'd say probably not."

UberPool and other vehicle-sharing services will impact rail travel less than buses. The sheer number of people trains can carry affords some economies of scale that are not replicable by individual Uber taxis. In addition, Uber is unlikely to be quicker than rail travel, especially when travelling between cities. As Andrew Byrne, Head of Public Policy in the UK and Nordics at Uber, explains, Uber complements rather than conflicts with rail travel.

> "It's not all about the big headline projects such as the skyways and the maglev trains. Lots of the improvements in mass transport will be incremental change through introducing technology."

"Around 35% of our rides either start or finish at a major transport hub, so it is very complementary to existing public transport systems, particularly rail," he said. "This is particularly true at night. The impact Uber has on black taxis is hard to gauge, primarily because Transport for London doesn't collect data on the number of rides. Around 30% of Uber rides start in zones 3-6. If you went to the end of your road in zone 5 and tried to hail a cab you would be waiting a long time."

Nonetheless, rail operators are also innovating. As Lara Burch, Partner at Osborne Clarke, explains, innovation in rail travel will be characterised by incremental technological improvements, rather than any radical change in business model.

"It's not all about the big headline projects such as the skyways and the maglev trains," she said. "Lots of the improvements in mass transit will be incremental change through introducing technology. For example, the process of digitising signals is not a headline-grabbing change, but it will enable operators to know exactly where their trains are and, therefore, enable them to put more trains on the network. Innovations like ticketless travel also improve passenger flow through stations and therefore reduce the need for new infrastructure."

Public or private sector – where does responsibility lie?

The wide-ranging legal and regulatory obstacles to the implementation of new transport systems can only be overcome with government help. The public sector, be that at city, national or European level, therefore has a strong role to play in creating the right legal frameworks in which transport innovation can flourish.

A number of initiatives are already underway. The driverless vehicle case study in Milton Keynes highlighted earlier is a good example. The initiative is being run by the UK Transport Systems Catapult, a non-profit organisation run by the country's innovation agency Innovate UK, which is mainly financed though government funds. Milton Keynes Council is a partner in the project.

At the other end of the spectrum, many initiatives are in progress at the European level. One notable initiative is the European Commission public consultation on the provision of EU-wide multimodal travel information services. Specifically, the consultation aims to establish specifications to ensure such services are deployed in a way that is interoperable across modes and European countries. It this hoped this will accelerate the deployment of EU-wide multimodal travel information services.

Local government intervention is also needed to ensure that new transport business models are adequately regulated and competing fairly with existing industries. Uber is a classic case in point.

"Uber has succeeded and had a positive impact in cities where it has been embraced by the local government and the city, enabling it to be harnessed and used," explained Andrew Byrne, Head of Public Policy in the UK and Nordics at Uber. "Many cities have established a regulatory structure which enables a complementary coexistence between new systems like Uber and incumbent industries such as taxis, private hire and buses."

But the powers and responsibilities of local government are changing. In the UK for example, a devolution programme is underway that will transfer certain budgets and decision making power from central government to local authorities. This includes the Cities and Local Government Devolution Bill, which is currently passing through parliament and the Buses Bill, which gives combined authority areas and city mayors more autonomy over running local bus services. A specific devolution agreement has been forged with Greater Manchester that will see a city mayor elected in 2017. The mayor will have control over bus services, smart ticketing and a specific transport budget.

While the devolution programme creates opportunities for cities to expedite investment in transport infrastructure, it also creates a series of questions. Will transport fall behind in cities without devolved powers and an elected mayor? How can transport interoperability between cities be ensured if local authorities are free to pursue their own initiatives? These questions will start to be answered as devolution continues.

But the public sector alone cannot foster innovation in transport. Consistent feedback from interviewees was that government agencies need to set the right legal and regulatory structure and perhaps fund some initial demonstrators, but then it's up to the private sector. Of course this does not apply to publically owned transport, where the pace of innovation is set by the public transport operator. But even in this setting the private sector has a role to play in demonstrating which new technologies are available for implementation.

It is vital for the private and public sector to work collaboratively and communicate closely in a variety of ways, from ensuring regulatory structures match the needs of industry to making sure large public transport operators communicate which issues they want the private sector to help address.

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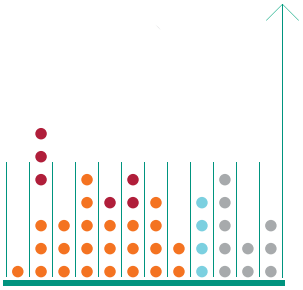

Conclusion

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Improving urban mobility doesn't necessarily need to involve huge infrastructure investment. In fact, the panel of experts interviewed for this report consistently mentioned that better analysis of and access to existing data can generate significant improvements in how transport is managed.

The second core message emanating from our series of interviews was that legal and regulatory issues are the largest obstacles to transport innovation and the opportunity for far sighted regulators to enable innovation.

Yet despite the challenges, the case studies outlined at the beginning of this report show that innovative transport initiatives are being implemented. What are the ingredients of success? Collaboration is a common theme. This might involve collaboration between the private and public sectors, collaboration between different government departments or even collaboration between large and small private-sector companies. Truly innovative transport initiatives are being put in place when these partnerships are successfully forged.

For more on smart cities and how OC is involved in developing smart cities, please visit ocsmartcities.com.

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